

Course's Name analog
communication
Course's Number :
Exam's Period : 1 hours
Questions' Number :
Total Mark : 30
Pages' Number :

Palestine Technical University - Kadoorie

Instructor's Name : Mahmoud Ahmad

Student's Name:
Student's Number:
Section's Number:
Exam's Date : 20
Form :

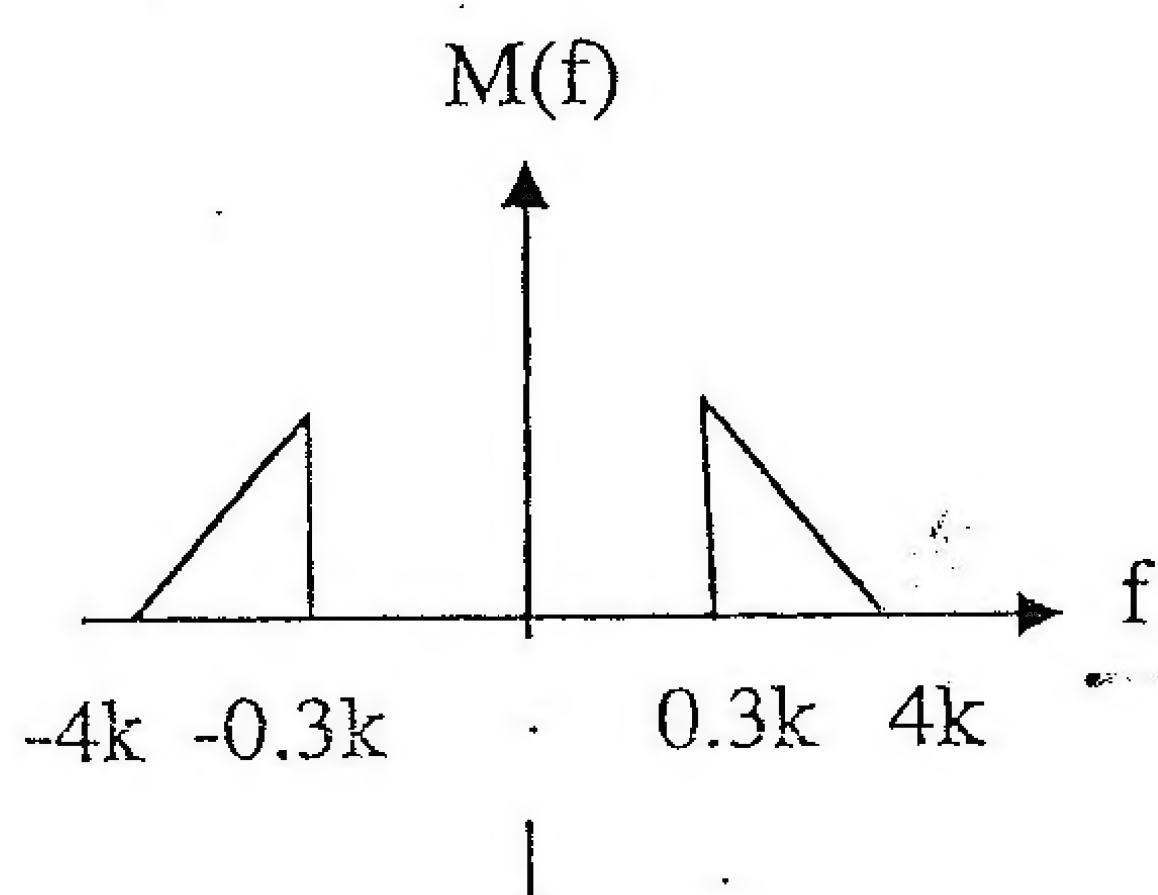
Analog Comm
1st Exam



first..... Exam
second..... Semester 2012/2013

Q1)(part1) Consider a base band signal $m(t)$ having a spectrum as shown below. is the input of the modulator below.

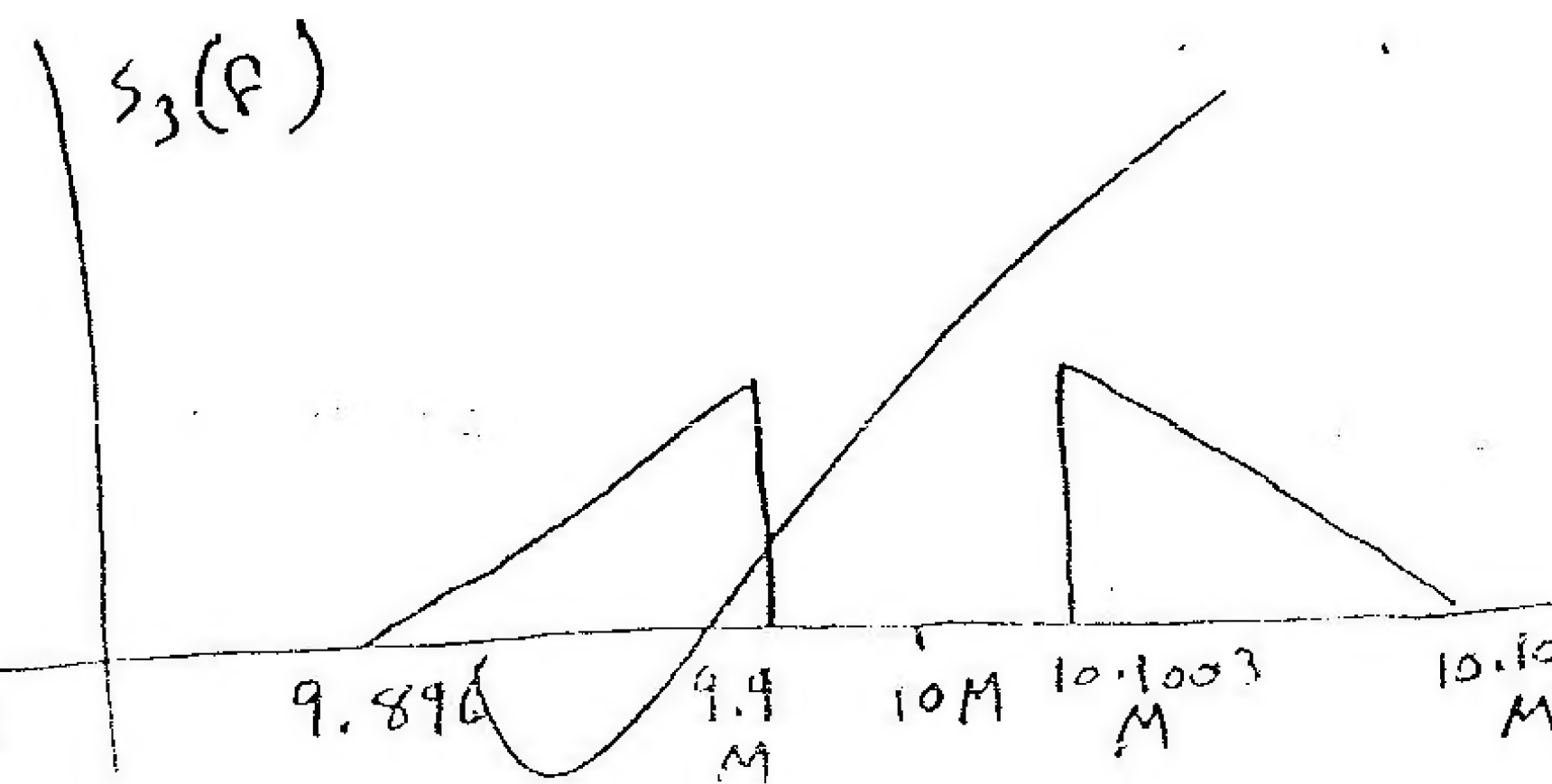
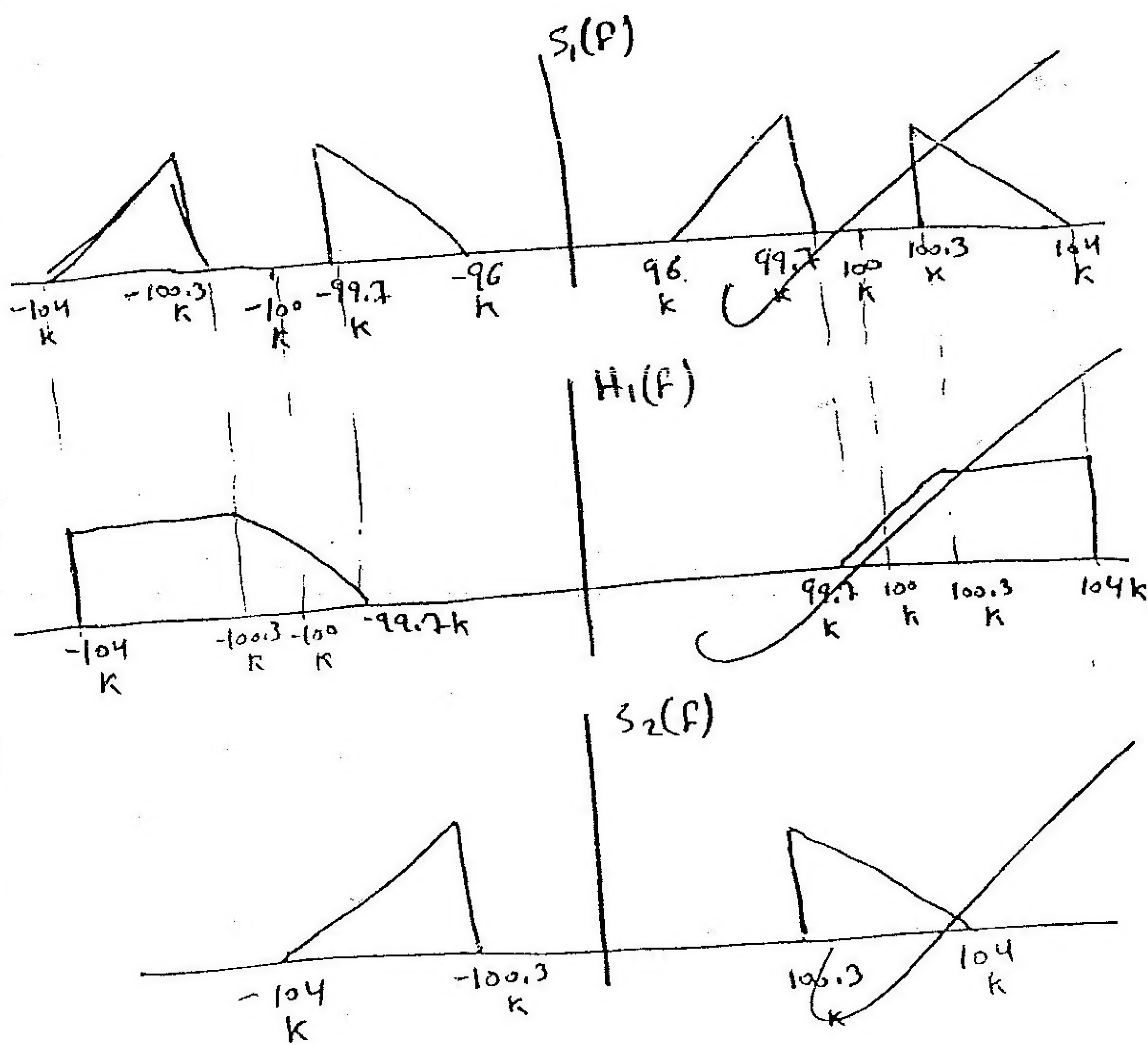
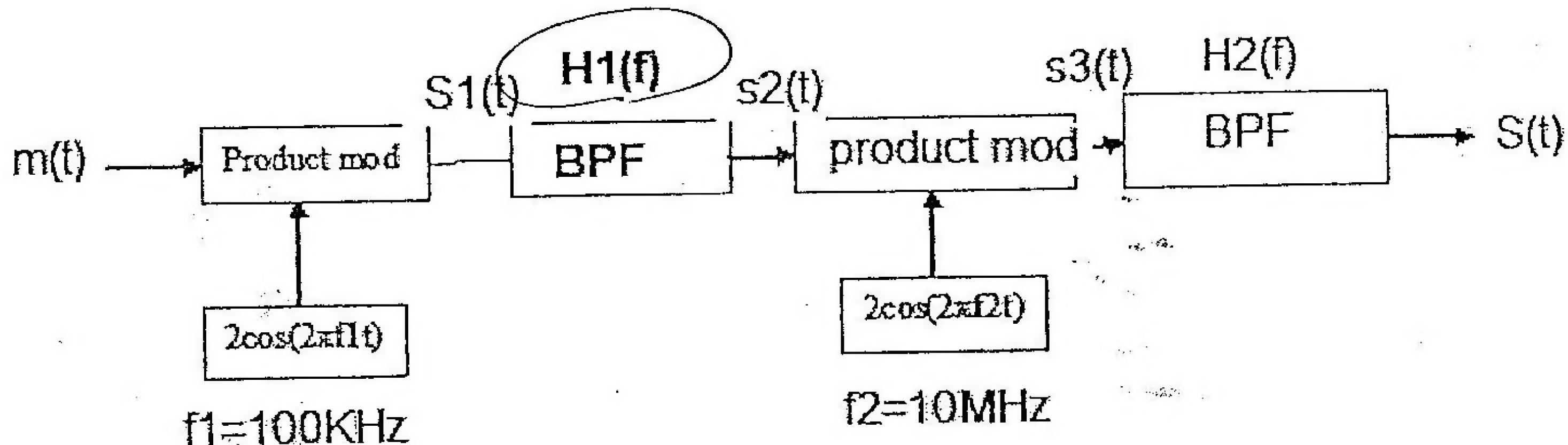
- draw the spectrum of $S_1(t)$ (1)
- draw the amplitude spectrum of the BPF $H_1(f)$ to obtain a SSB-USB modulated signal at its output and draw the spectrum of $S_2(t)$ (2)
- draw the spectrum of $S_3(t)$ (1)
- Draw the amplitude spectrum of BPF2 to obtain SSB-USB at its output and draw the spectrum of $S(t)$ (2)



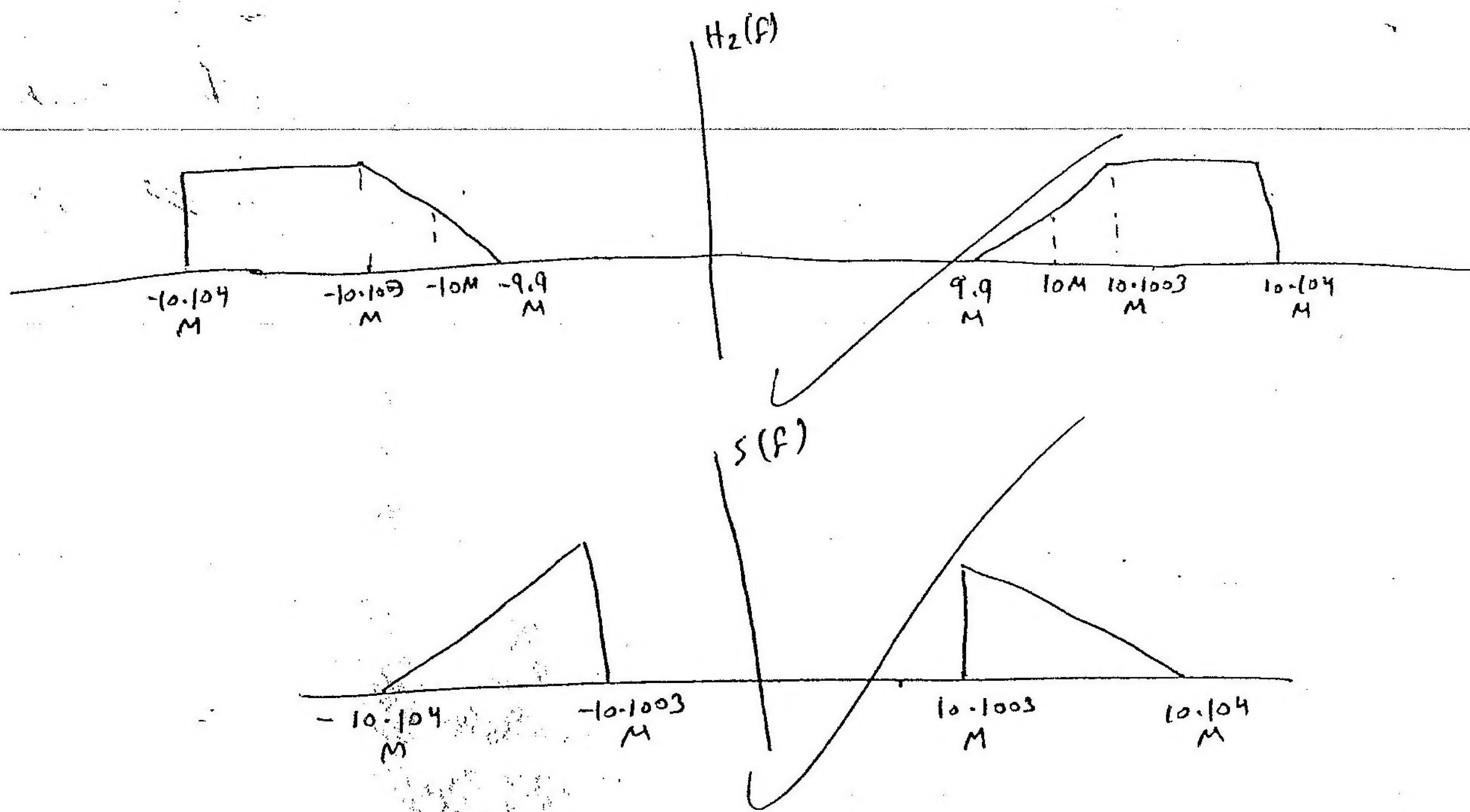
$$S_1(t) = m(t) \cos 2\pi f_1 t$$

$$S_3(t) = S_2(t) \cos 2\pi f_2 t$$

اتصالات تماثلية
تخضع الاتصالات
الاصغاف الاول

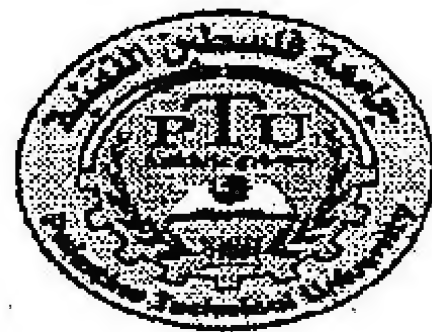


تم الرفع بواسطة
م. د. عبد الواسع



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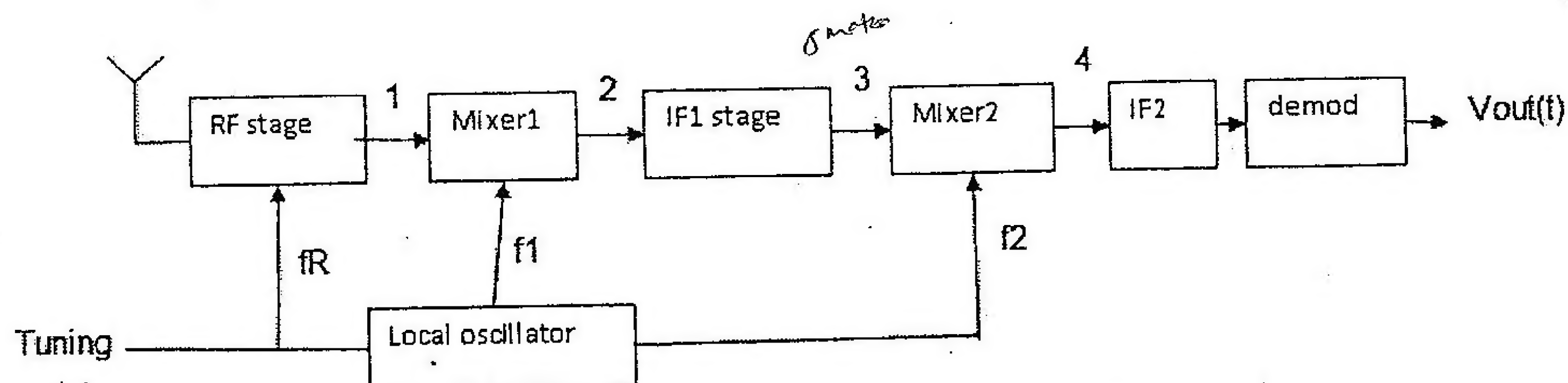
Instructor's Name : Mahmoud Ahmad

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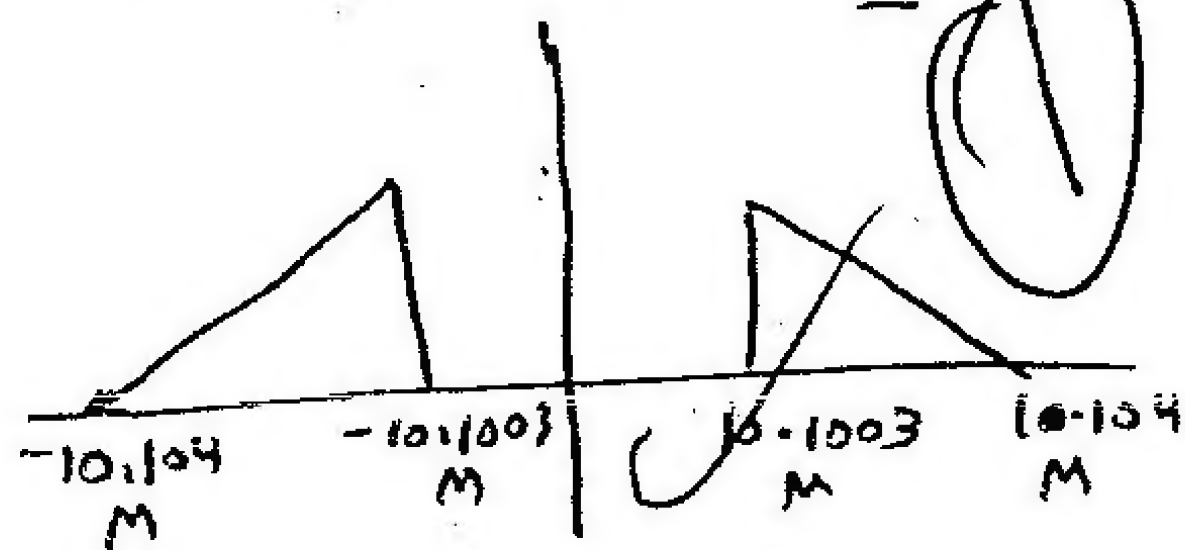
Q1)(part 2) The modulated signal in part 1 is the input of the following superhetrodyne receiver

- What is the value of f_r draw the spectrum at 1 (1)
- What is the value of f_1 such that the frequency in IF1 stage is 5MHz draw the spectrum of the filter at the IF1 stage (2)
- What is the value of f_2 such that the frequency in IF2 is 0.455MHz draw the spectrum at the output of IF2 stage (2)
- Draw the block diagram of a demodulator to obtain $m(t)$ at the output, what is the carrier frequency of the oscillator at the demodulator. Show that the output of the demodulator is $m(t)$ (2)



(a) $f_r = 10 \text{ MHz}$

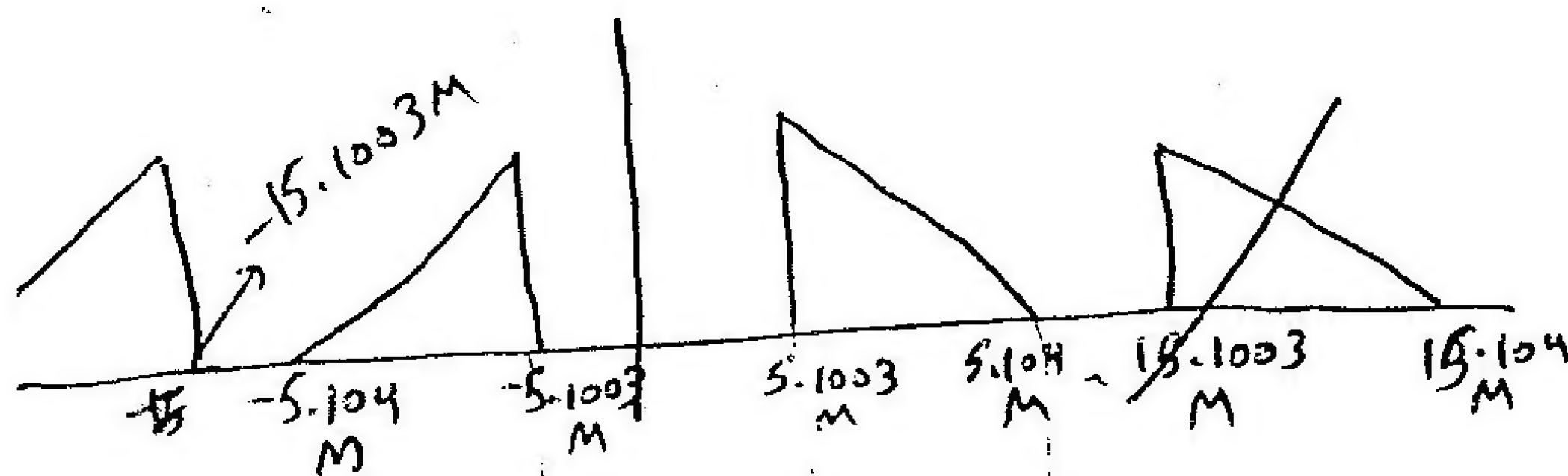
The spectrum at 1



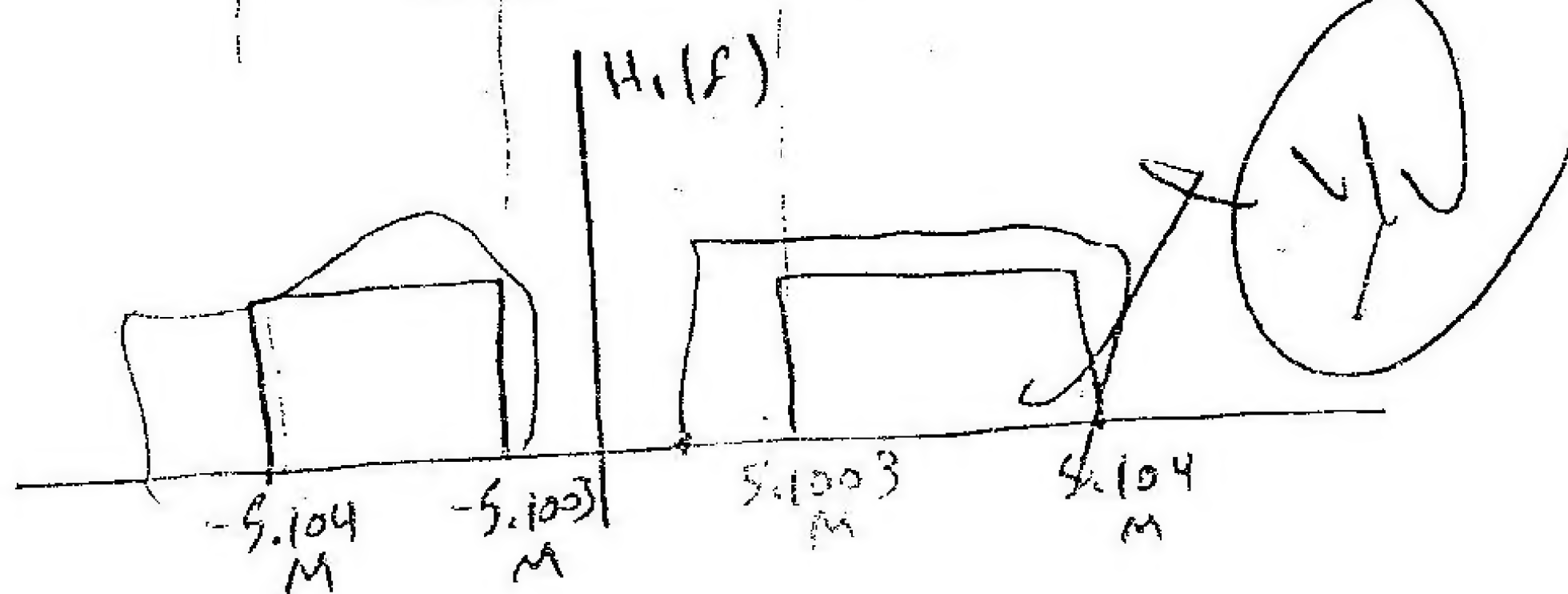
(b) $f_r - f_1 = 5 \text{ MHz}$

$10 \text{ MHz} - f_1 = 5 \text{ MHz}$

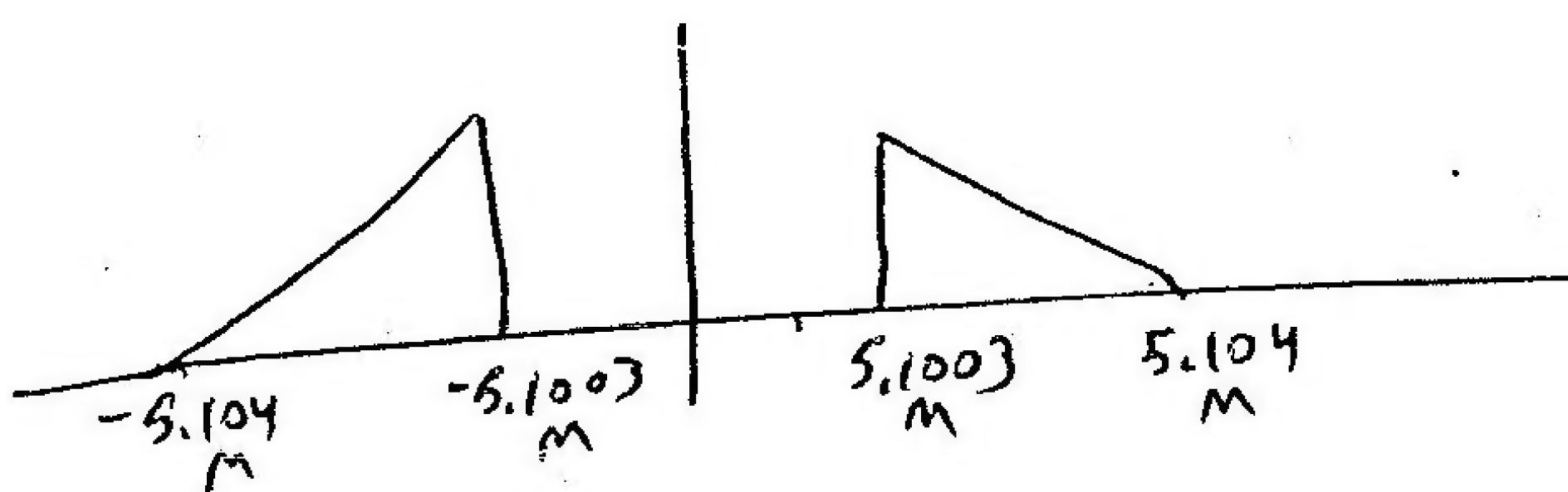
$f_1 = 5 \text{ MHz}$



The spectrum at 2



The spectrum at 3



$f_{IF1} - f_2 = 0.455 \text{ MHz}$

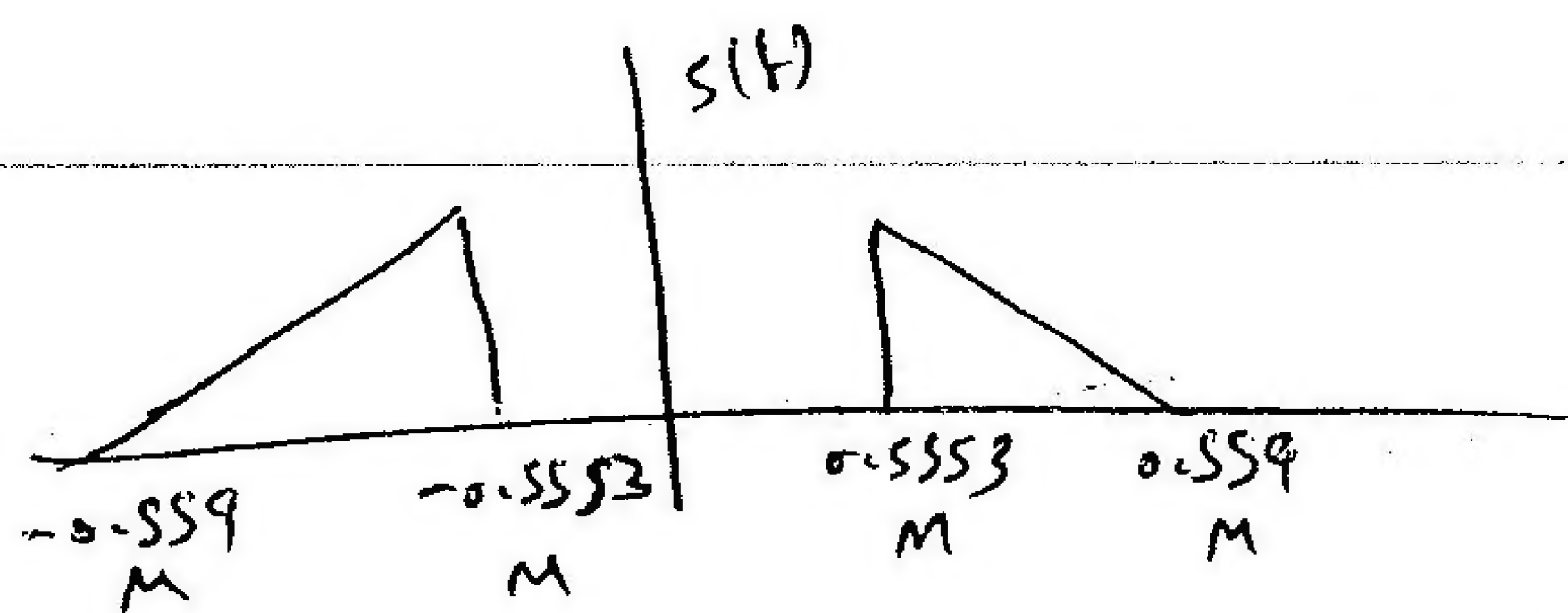
$f_2 = 5 \text{ MHz} - 0.455 \text{ MHz} = 4.545 \text{ MHz}$



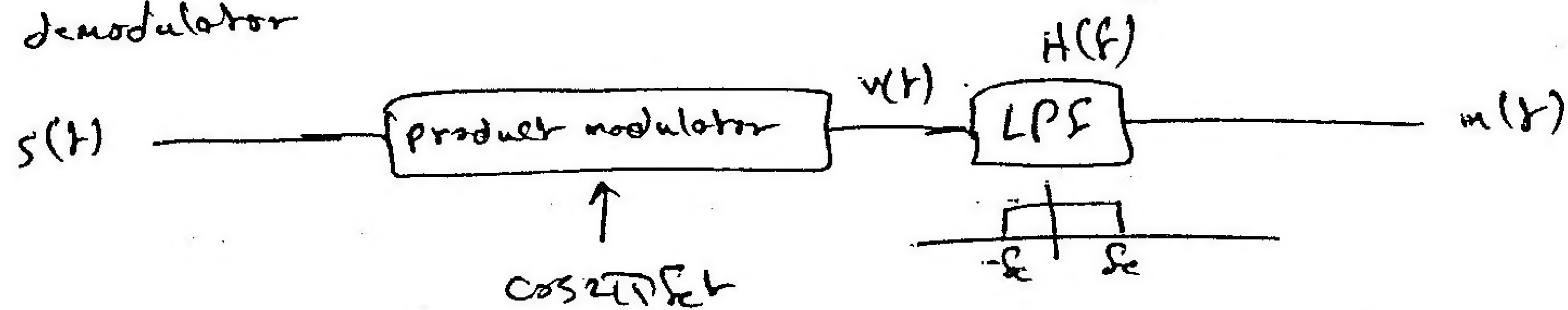
The spectrum at 4



after $1/2$



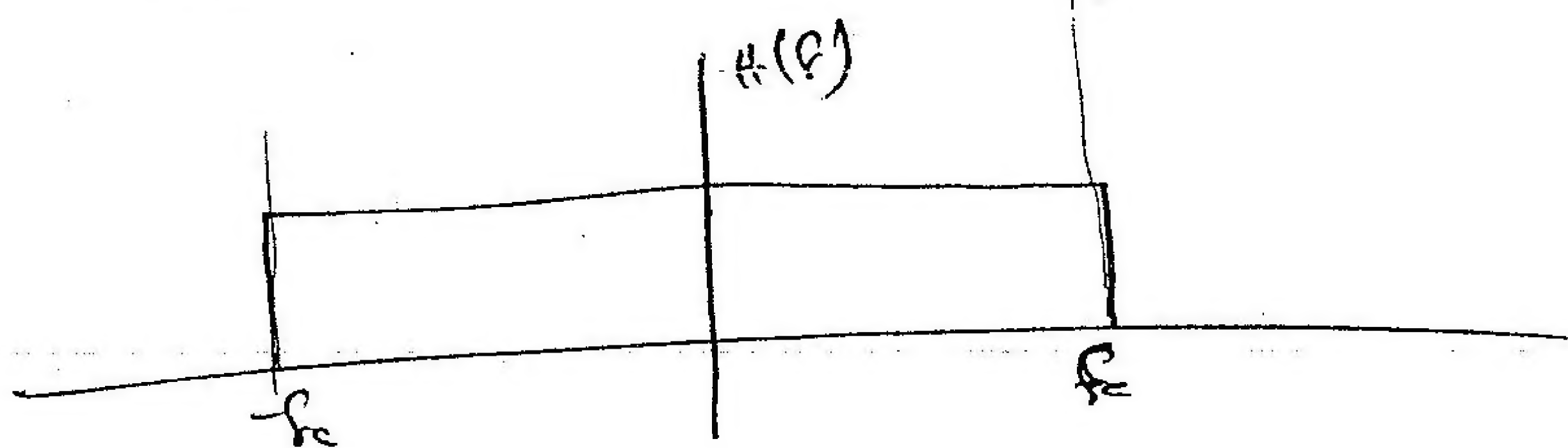
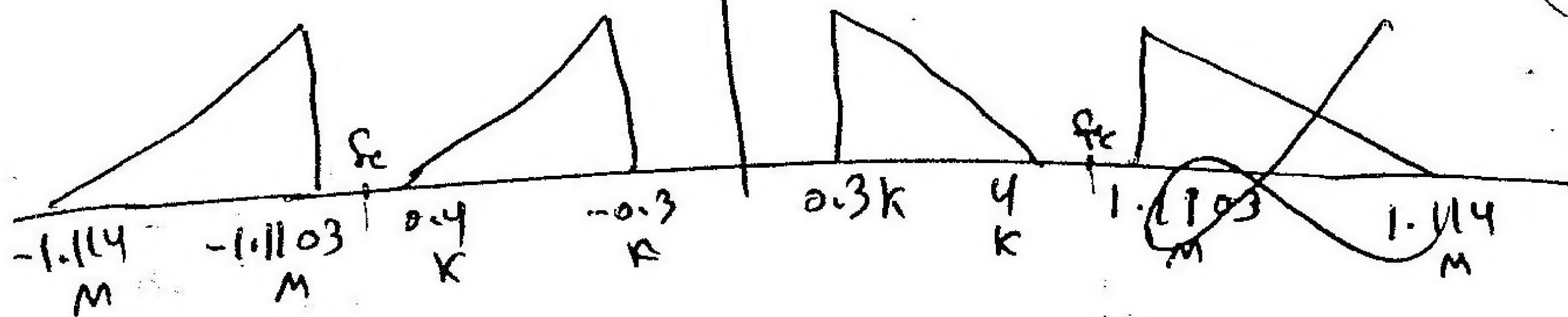
the demodulator



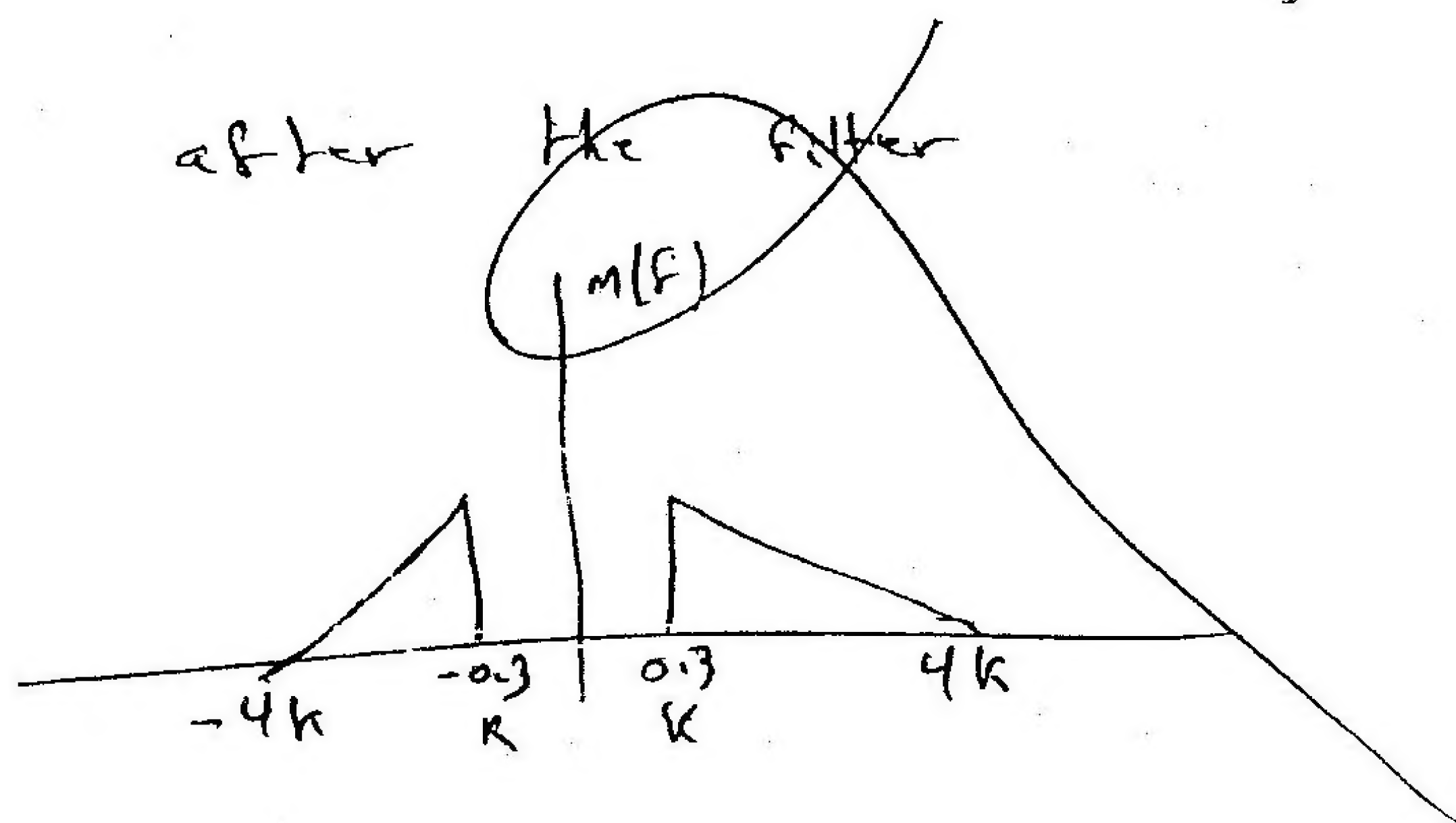
f_c must be $0.555M$ Hz

$$v(t) = s(t) \cos 2\pi f_c t \quad \text{with } f_c = 0.555M \text{ Hz}$$

~~u(f)~~ $U(f)$



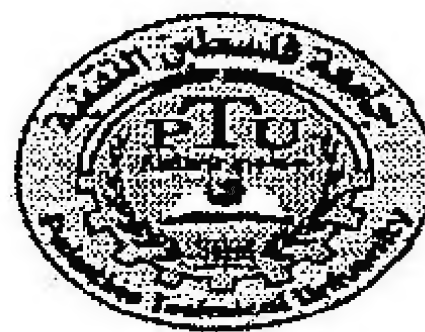
after the filter



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Q2) (9 marks) Consider a modulating wave

$$m(t) = 2 \cos(2\pi * 10^3 t) + 2 \cos(2\pi * 5 * 10^3 t) \text{ and a carrier wave}$$

$$c(t) = \cos(2\pi * 100 * 10^3 t)$$

Assuming that the modulator have an amplitude sensitivity of 0.4

- Write the time expression for the AM modulated wave (1)
- What is the modulating factor for the modulator and what is the percent modulation (1)
- Find and draw the spectrum of the modulated wave. (3)
- Find the total power of the side bands and the total power of the carrier and hence find P_{sb}/P_T (2)
- Suggest a demodulator for this system to recover the base band signal from the incoming wave and draw the block diagram for such demodulator. (1)
- In your opinion what are the disadvantages of AM modulation (1)
- Draw the block diagram to generate the carrier from the incoming wave. (1)

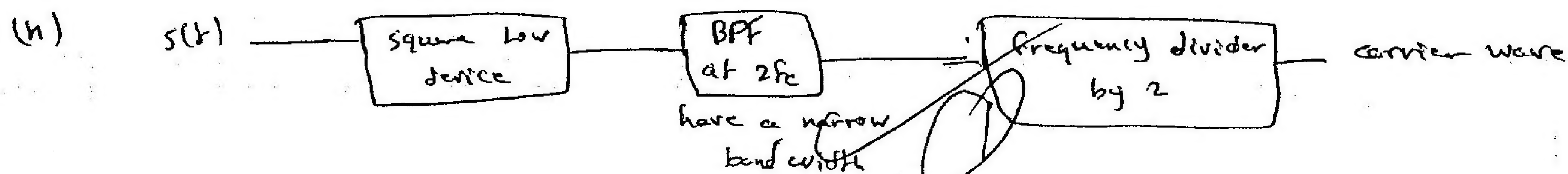
$$(a) s(t) = A_c [1 + k_a m(t)] \cos 2\pi f_c t$$

$$s(t) = [1 + 0.8 [\cos 2\pi * 10^3 t + \cos 2\pi * 5 * 10^3 t]] \cos 2\pi * 100 * 10^3 t$$

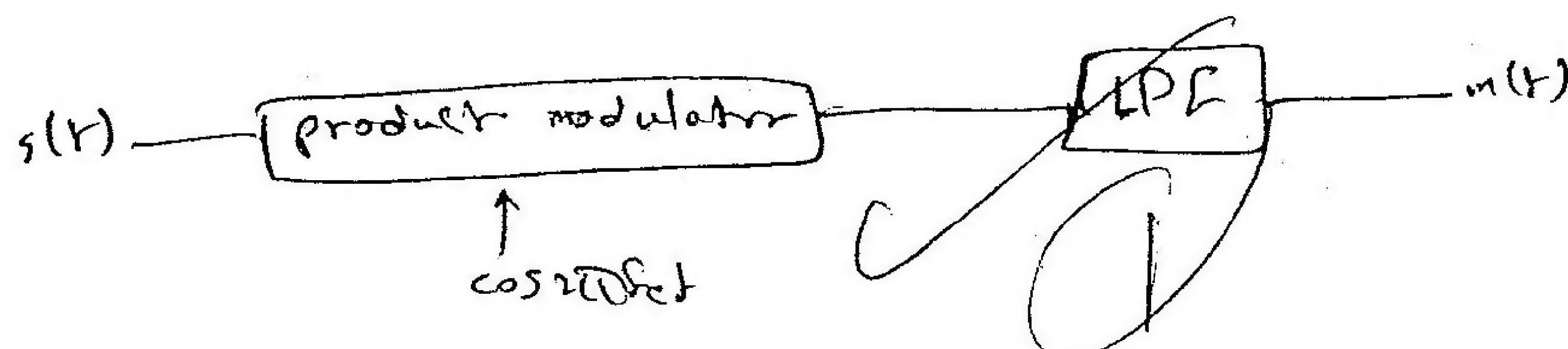
$$(b) M = k_a A_m = 0.4 * 2 = 0.8$$

$$\text{percent modulation} = k_a(m(t)) * 100 = 0.8 * 100 = 80\%$$

(g) The disadvantages of AM modulation is waste of power and waste of Band width



(f) The demodulator is coherent detector



$$m(t) = 2 \cos 2\pi \times 10^3 t + 2 \cos 2\pi \times 5 \times 10^3 t$$

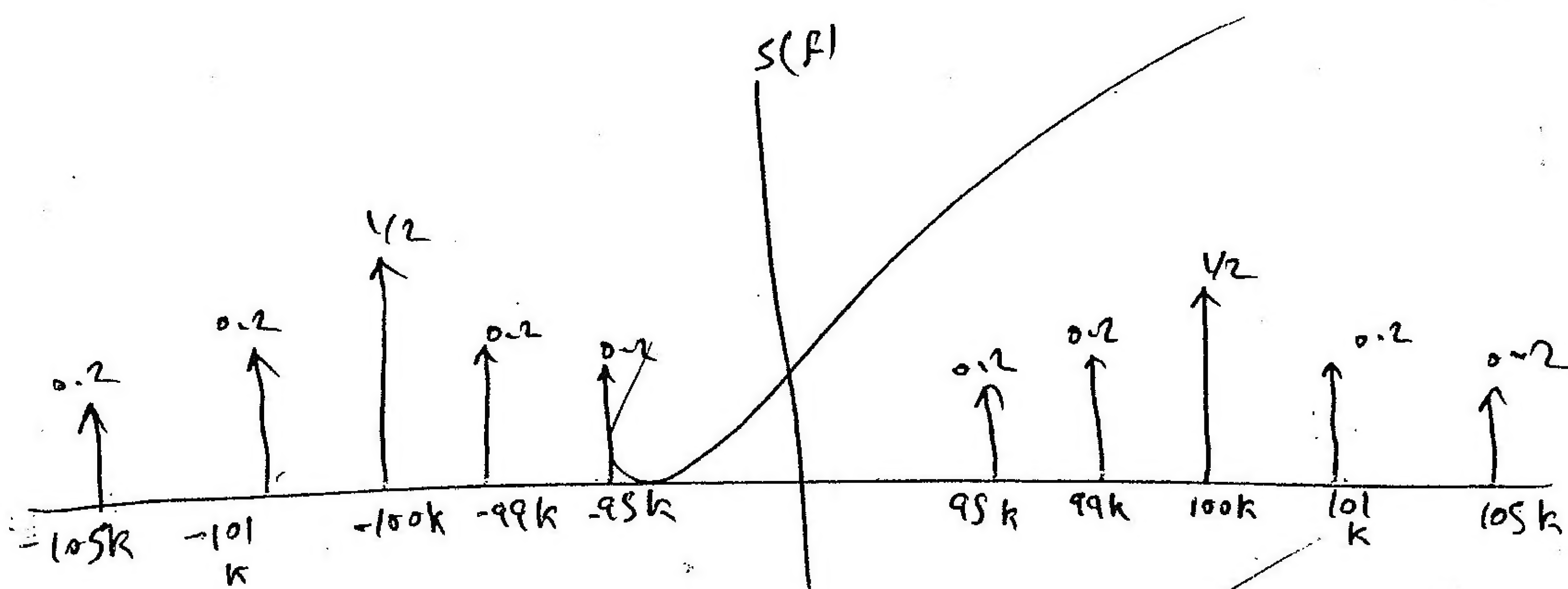
$$c(t) = \cos 2\pi \times 100 \times 10^3 t$$

$$s(t) = \left[1 + 0.8 \left[\cos 2\pi \times 10^3 t + \cos 2\pi \times 5 \times 10^3 t \right] \right] \cos 2\pi \times 100 \times 10^3 t$$

$$= \cos 2\pi \times 100 \times 10^3 t + 0.8 \cos 2\pi \times 10^3 t \cos 2\pi \times 100 \times 10^3 t + 0.8 \cos 2\pi \times 5 \times 10^3 t \cos 2\pi \times 100 \times 10^3 t$$

$$= \cos 2\pi \times 100 \times 10^3 t + 0.4 \left[\cos 2\pi \times 99 \times 10^3 t + \cos 2\pi \times 101 \times 10^3 t \right]$$

$$+ 0.4 \left[\cos 2\pi \times 95 \times 10^3 t + \cos 2\pi \times 105 \times 10^3 t \right]$$



$$P_{sb} = (0.2)^2 \times 8 = 0.32$$

$$P_T = P_{sb} + P_{carrier} = 0.32 + (0.5)^2 \times 2 = 0.82$$

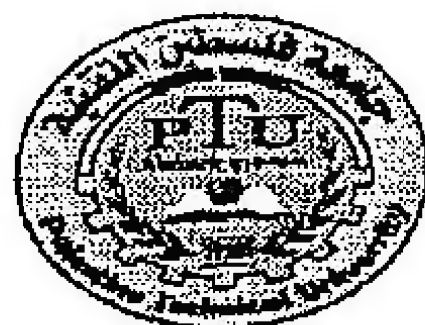
~~$$0.32 + 0.5$$~~

$$\frac{P_{sb}}{P_T} = \frac{0.32}{0.82} = 0.39$$

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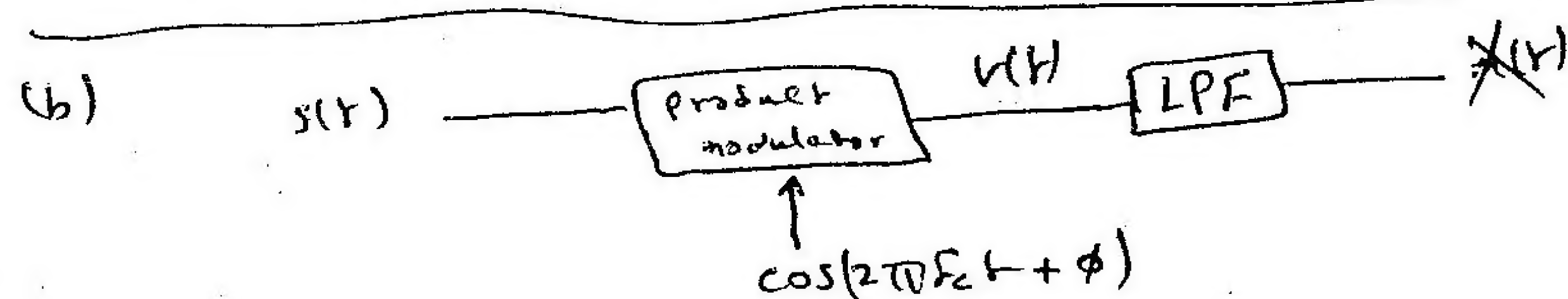
Q3) a) SSB modulation is not suitable for image transmission why? (1)

b) In using coherent detector in SSB modulation there must be full synchronization in both phase and frequency between the incoming signal and the local oscillator used explain in detail the effect of the phase and frequency error on the incoming wave. (3)

c) Draw the block diagram for the VSB modulator and write the specifications of the filter used. (2)

d) Draw the block diagram for a suitable demodulator for VSB modulation (1)

(a) because the image contains very low frequencies, and we can't separate the upper side band from the lower side band.



Let take SSB - USB

$$s(t) = \frac{1}{2} A_c m(t) \cos 2\pi f_c t - \frac{1}{2} A_c \hat{m}(t) \sin 2\pi f_c t$$

$$v(t) = \frac{1}{2} A_c m(t) \cos 2\pi f_c t \cos(2\pi f_c t + \phi) - \frac{1}{2} A_c \hat{m}(t) \sin 2\pi f_c t \cos(2\pi f_c t + \phi)$$

$$= \frac{1}{4} A_c m(t) [\cos \phi + \cos(4\pi f_c t + \phi)] - \frac{1}{4} A_c \hat{m}(t) [\sin \phi + \sin(2\pi f_c t + \phi)]$$

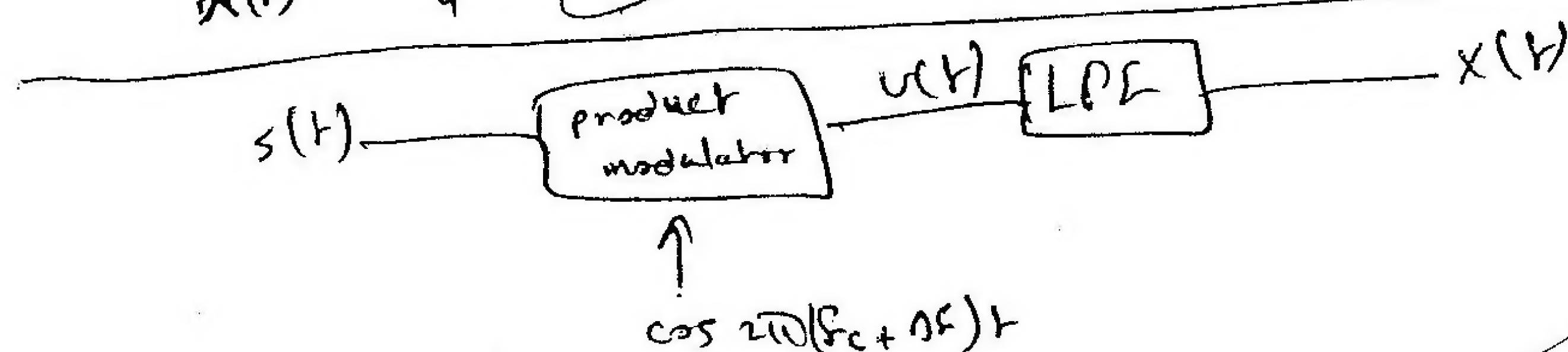
after the LPE

$$x(t) = \frac{1}{4} A_c m(t) \cos \phi + \frac{1}{4} A_c \hat{m}(t) \sin \phi$$

$$X(f) = \frac{1}{4} A_c \cos \phi M(f) + \frac{1}{4} A_c \sin \phi (-j \operatorname{sgn}(f)) M(f) \quad \text{for } f > 0$$

$$= \frac{1}{4} A_c M(f) [\cos \phi - j \sin \phi]$$

$$x(t) = \frac{1}{4} A_c M(t) e^{-j\phi}$$



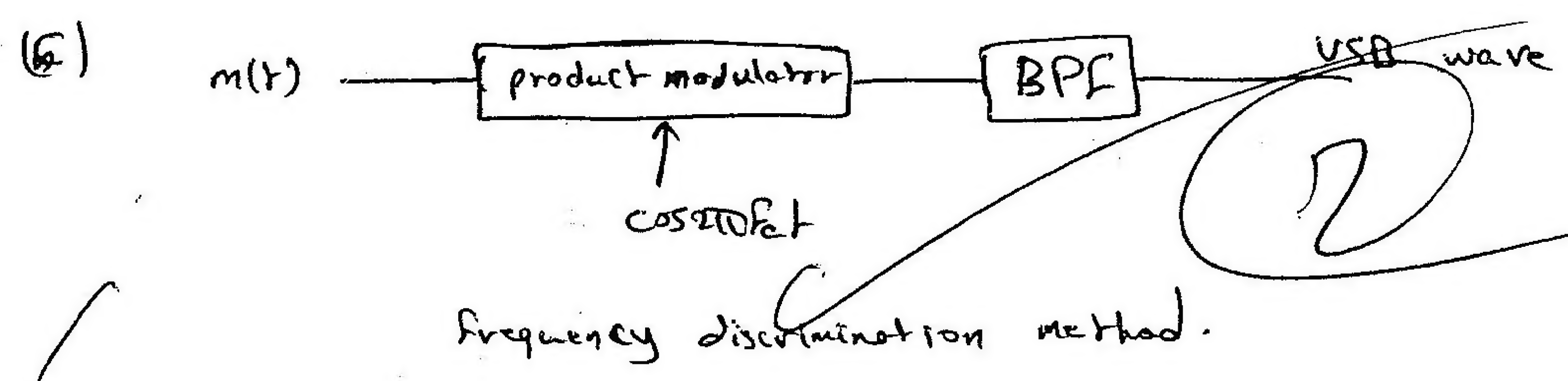
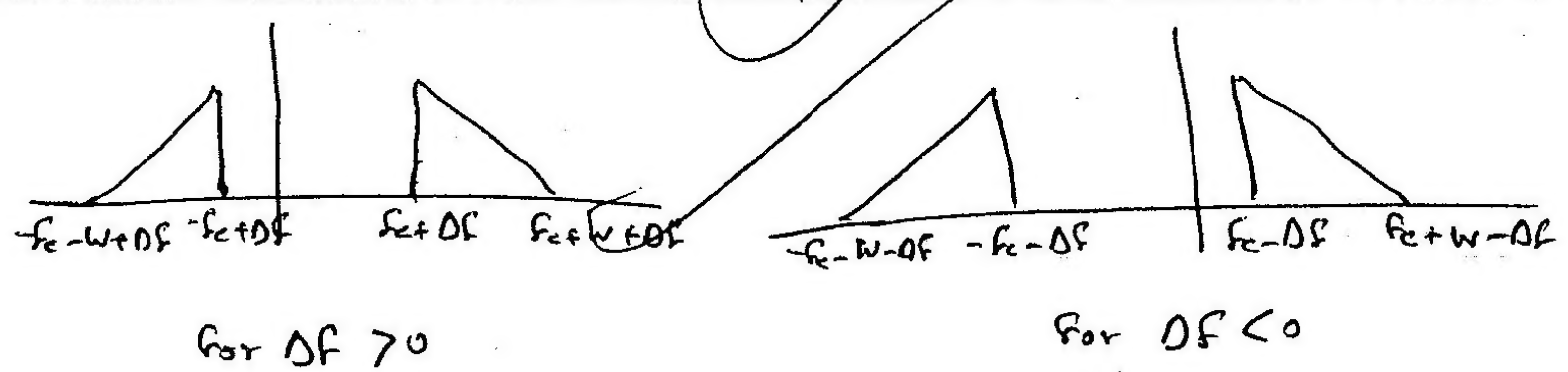
Let take SSB - USB

$$v(t) = \frac{1}{2} A_c m(t) \cos 2\pi f_c t \cos 2\pi(f_c + \Delta f)t - \frac{1}{2} A_c \hat{m}(t) \sin 2\pi f_c t \cos 2\pi(f_c + \Delta f)t$$

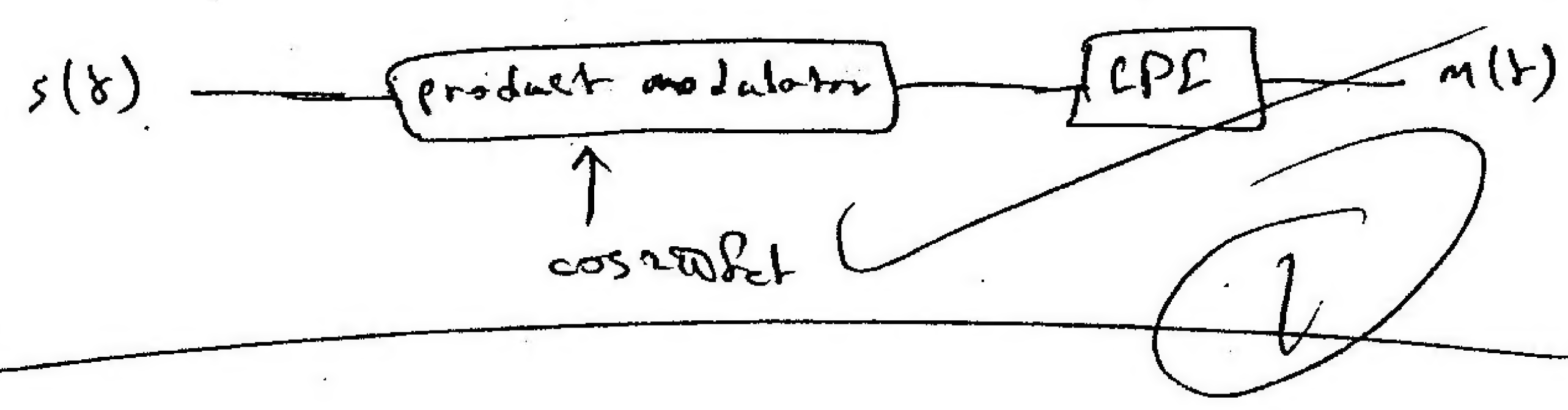
$$= \frac{1}{4} A_c m(t) [\cos 2\pi \Delta f t + \cos(4\pi f_c t + 2\pi \Delta f t)]$$

$$- \frac{1}{4} A_c \hat{m}(t) [\sin 2\pi \Delta f t + \sin(4\pi f_c t + 2\pi \Delta f t)]$$

$$x(t) = \frac{1}{2} A_c m(t) \cos 2\pi \Delta f t + \frac{1}{2} A_c \hat{m}(t) \sin 2\pi \Delta f t$$



(d) The demodulator of VSB is synchronous detector



The specifications of the filter

$$s(t) = \frac{1}{2} A_c m(t) \cos 2\pi \Delta f t \quad H(f)$$

$$\left[H(f - \Delta f) + H(f + \Delta f) \right] \text{ must be constant}$$